# GUIDANCE ON THE CLEANUP, TEMPORARY OR INTERMEDIATE STORAGE, AND TRANSPORT OF MERCURY WASTE FROM HEALTHCARE FACILITIES

## CONTENT



## INTRODUCTION

The UNDP GEF project involves demonstrating best practices for the management of mercury waste and promoting mercury-free devices. As health facilities phase out mercury devices, proper methods of storage and transport are needed. This document is intended for project countries where national norms and guidelines for cleanup, storage, and transport of mercury waste do not exist at this time. These suggested guidelines should become part of a broader plan for sequestration and phase-out of mercury.

## OBJECTIVE AND SCOPE OF THE GUIDANCE

**Objective**

The objective of this document is to provide guidance to health facilities on the cleanup and temporary on-site storage of mercury, the transport of mercury waste, and its intermediate storage at a centralized facility.

**Scope**

This guidance document deals with the following different forms of mercury waste from healthcare facilities:

- Elemental mercury collected from broken mercury devices
- Undamaged mercury thermometers and sphygmomanometers
- Devices and equipment containing elemental mercury (gastro-intestinal tubes such as Cantor tubes, esophageal dilators, bougie, and Miller-Abbott tubes; mercury switches, etc.)
- Broken glassware contaminated with elemental mercury (specifically, broken thermometers and sphygmomanometers)
- Fluorescent lamps (fluorescent tubes, compact fluorescent lights, UV germicidal lamps)
- Dental amalgam.

Not included in this document are other forms of mercury found in health facilities, namely, mercury-containing batteries, and mercury-containing chemicals such as Thimerosal used in some ophthalmic products, nasal sprays, and vaccines; Merbromin; diuretics containing mercury salts; mercury-based

preservatives, fixatives, and stains; cleaners and degreasers with mercury-contaminated caustic soda or bleach; and laboratory reagents that contain some mercury.[1]

This document provides guidance on the clean-up of mercury spills, especially spills resulting from the breakage of mercury thermometers and sphygmomanometers.

Two types of storage are considered in this document: (1) temporary storage on site (i.e., inside hospitals, clinics, and other health facilities) for the purpose of accumulation or sequestration of waste until such time as centralized storage or approved treatment and disposal facilities become available in the country; and (2) storage in a centralized facility for an intermediate period until such time as long-term storage (terminal storage), treatment or disposal facilities become available in the country. Intermediate storage should not exceed five years. This document also provides guidance on the transport of mercury waste from a health facility to an intermediate storage facility.

## How to Use this Document

Different parts of this document can be used at the level of a healthcare facility as part of a mercury reduction and phase-out program. Other parts may be useful at provincial or national levels. The guidance can be used as a basis for developing facility-specific guidelines, staff training, local or national policies, and planning at all levels.

Healthcare facilities should first assess current guidelines and practices dealing with mercury, the availability of materials and resources, and levels of staff training on mercury. (The UNDP GEF Project's PowerPoint presentation "Mercury: Its Properties, Sources, and Health Effects" could be used as an awareness-raising tool and is available at www.gefmedwaste.org.) In low-income settings, it may not be possible to obtain mercury decontaminant solutions or adopt a comprehensive approach to clean-up and storage, but some effort is better than no effort at all. Facilities should implement a phased plan to upgrade mercury management that begins with awareness-raising and policies to prevent dumping of mercury from broken sphygmomanometers and thermometers in the domestic waste, followed by simplified procedures that recover as much spilled mercury as possible while minimizing exposure of health workers and patients, and temporary storage arrangements that take into consideration worker health and safety. Priority should be given to aspects of the plan that have the most impact.

This guidance may be useful to provincial or national governments in developing plans and infrastructure for the packaging, off-site transport, and intermediate storage of mercury at central facilities, even as regional and international efforts proceed towards finding long-term solutions to the global mercury problem. Although this guidance is focused on mercury from health care, many of the concepts may be applicable to other sources of mercury waste.

[1] "Instruments, Products, and Laboratory Chemicals Used in Hospitals That May Contain Mercury," Publication 2-03 in *Going Green: A Resource Kit for Pollution Prevention in Health Care*, Health Care Without Harm, November 5, 2002.

## BASIC INFORMATION

**Properties**

Elemental mercury (Hg) is a heavy, silvery metal that melts at -38.9°C and boils at 357°C. It is the only metal that is liquid at room temperature. Drops of mercury have a high surface tension and appear round. The liquid droplet is very mobile and combines with other metals such as tin, copper, gold, and silver to form alloys (solid solutions called amalgams). An exception is iron which does not amalgamate with mercury. The density of mercury is 13.5 g/cm$^3$ at 25°C. Mercury has the highest volatility of any metal, forming a colorless, odorless gas.

When mercury is spilled, it can break into very small droplets resulting in a large total surface area. These tiny droplets can volatilize at a rate faster than room ventilation can safely dilute the mercury concentration. The vaporization rate of elemental mercury approximately doubles with every temperature increase of 10°C. Air that is saturated with mercury vapor at 25°C is a thousand times higher than the occupational exposure limit of 0.02 mg of mercury vapor per m$^3$ in air.[2] Small droplets of spilled mercury can lodge in cracks, adhere to carpet fabric, mix with dust, go down drains, stick to the soles of shoes, and dissolve to form alloys with the metals in watches and jewelry. Some materials are resistant to mercury.[3]

**Toxicity**

The toxic effects of mercury are well known.[4] Mercury vapor affects the central and peripheral nervous systems, lungs, kidneys, skin, and eyes. It also affects the immune system and is mutagenic. Acute exposure to high concentrations of mercury vapor causes severe respiratory damage, while chronic exposure to lower levels is primarily associated with central nervous system disorder, behavioral changes, and effects on the peripheral nervous system. Chronic mercury exposure can cause eyelid tremor and disturbances of vision.

The symptoms of acute inhalation of high levels of mercury vapor include chills, nausea, malaise, chest pains, shortness of breath, coughing, gingivitis, salivation, and diarrhea. Symptoms of chronic exposure to mercury include weakness; weight loss; gastrointestinal disturbances; a tremor that begins with the fingers, eyelids, and lips and progresses to generalized trembling of the body and violent spasms of the extremities; and behavioral and personality changes including increased excitability, memory loss, insomnia, and depression. Additionally, there may be a painful scaling or peeling of the skin of the hands and feet.

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[2] Recommendation from the Scientific Committee on Occupational Exposure Limits for elemental mercury and inorganic divalent mercury compounds, SCOEL/SUM/84, European Commission, May 2007; the threshold limit value (daily exposure level above which it is believed a worker could suffer adverse health effects) or TLV assigned by the American Conference of Governmental Industrial Hygienists (ACGIH) is 0.025 mg per m$^3$ averaged over a normal 8-hour work day and a 40-hour work week; the National Institute for Occupational Safety and Health (NIOSH) has a recommended exposure limit (REL) for mercury vapor of 0.05 mg per m$^3$ as a time-weighted average (TWA) for up to a 10-hour work day and a 40-hour work week; the permissible exposure limit (PEL) for mercury vapor is a ceiling value of 0.1 mg per m$^3$ in air according to the U.S. Occupational Safety and Health Administration (OSHA).

[3] Examples of materials resistant to mercury at room temperature are: gray and ductile cast iron, carbon steel, 304 and 316 stainless steel, Hastalloy C, titanium; epoxy, high density polyethylene, crosslinked polyethylene, polypropylene, polyethylene terephthalate, polyvinyl chloride, polyvinylidene fluoride, polyetheretherketone; nitrile rubber (Buna-N), chloroprene rubber (neoprene), fluorine rubber, chlorosulfonated polyethylene; glass, and ceramics.

[4] Occupational Safety and Health Guideline for Mercury Vapor, U.S. Occupational Safety and Health Administration, Washington, DC; http://www.osha.gov/SLTC/healthguidelines/mercuryvapor/recognition.html

**Persistence** Mercury is not biodegradable and persists in the environment. When released into the air, it cycles between the air, land, and water, and undergoes a series of complex chemical and physical transformations resulting in other forms of mercury. Elemental mercury is the most common form of mercury in the air. In aquatic systems, mercury is transformed into organic forms, such as methyl mercury which is more toxic than inorganic forms and bioaccumulates in fish and other wildlife as it moves up the food chain.

**Principles** Procedures for handling and storing mercury waste must take into account its weight, mobility, high volatility, ability to form amalgams, severe inhalation hazard, ability to be absorbed through skin and cause skin irritation and burns, danger to the eyes, and the adverse health effects due to chronic exposure at low concentrations.

In general, controlling exposures to occupational hazards is based on a hierarchy of controls, which can be summarized as follows:

- Elimination
- Substitution
- Engineering controls
- Administrative controls
- Personal protective equipment.

Elimination of mercury and substitution with mercury-free alternatives are at the top of the hierarchy. A mercury phase-out plan involves, among others, conducting an inventory, decommissioning mercury devices, safe packaging and temporary storage of unbroken mercury devices, procurement of non-mercury devices that meet standards, training on the use of non-mercury devices, and a preventive maintenance program. Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls will typically be independent of worker interactions to provide a high level of protection. Administrative controls involve safe workplace procedures, training, awareness-raising, and warning signs. Personal protective equipment or PPE is equipment worn to protect workers from serious workplace injuries or illnesses due to exposure to the chemical.

# CLEAN-UP OF SMALL MERCURY SPILLS IN A HEALTHCARE FACILITY

## 1.0 Planning

The objectives of safe management of mercury waste in a healthcare facility are to minimize exposure to patients, health workers, waste workers, and the community, and to prevent environmental pollution. In order to accomplish these objectives, a mercury waste management plan is essential. A plan should include:[5]

- *Education and training of staff and community* – awareness-raising, public education, periodic training on mercury management, simulation (response to mock spills) as part of training

[5] Adapted from "Managing Small Mercury Spills," Fact Sheet, Health Care Without Harm Europe (Praha, Czech Republic) and Health & Environmental Alliance (Brussels, Belgium), October 2006.
http://www.noharm.org/europe/issues/toxins/mercury/resources.php

- *Proper maintenance of mercury devices* – safe procedures for calibration and preventive maintenance
- *Appropriate labeling and collection* – segregation of mercury from infectious and regular wastes, use of appropriate containers, labeling
- *Mercury spill management* – spill kits, proper procedures, staff training
- *Mercury waste collection plan* – procedures for on-site storage and transport, a designated storage area
- *External management strategies* – take-back arrangements with vendors for used or obsolete mercury devices, arrangements with approved mercury recycling facilities (if available), phase-in of non-mercury devices
- *Proper disposal methods* – transport to approved treatment and disposal facilities (if available)

Mercury plans and policies should also consider such critical issues as:

- Ensuring that a competent staff person trained in mercury spill cleanup is always available
- Ensuring that personal protective equipment is always available for the cleanup staff
- Training for all staff on how to respond to a mercury spill, how to secure an area in the event of a mercury spill, and who to report a spill to.
- Guidelines that specify the circumstances when the patient(s), visitors, and staff should be evacuated from the area before cleanup
- Guidelines that specify what to do with mercury spills that occur during a medical or surgical procedure
- Guidelines that specify when a room is "clean enough" to re-occupy
- Preparation of incident reports that describe the spills, the cleanup methods used, unusual circumstances, and follow-up
- Documentation of training of general staff and staff specializing in mercury cleanup; documentation of each spill incident; use of documentation to evaluate causes of incidents, effectiveness of responses, medical monitoring of individuals exposed to mercury, and preventive measures; and regular reporting of results to the administration.

The healthcare facility should be prepared for a spill in any area of the hospital where mercury-containing devices are used.

## 2.0 Spill Kit for a Small Mercury Spill in a Healthcare Facility

Although mercury spill kits are commercially available, a spill kit can be made by putting together the following items and storing them in a marked box or portable container:[6]

- □ Step-by-step instructions
- □ Personal protective equipment (PPE):
  - Several pairs of rubber or nitrile gloves

[6] Adapted from "Managing Small Mercury Spills," Fact Sheet, HCWH Europe and HEAL (ibid.); U.S. Environmental Protection Agency's website "Mercury Releases and Spills: Cleanups and Proper Disposal," updated December 2, 2009 (http://www.epa.gov/hg/spills/); "Mercury Spill Information and Cleanup Guidance," Indiana Department of Environmental Management, May 2007; "Personal Protective Equipment Information for Mercury," Canadian Centre for Occupational Health and Safety, updated December 21, 1998; and comparisons of various commercial spill kit contents.

- Safety goggles or protective eyewear
- Respiratory protection:
  - Fit-tested full- or half-facepiece air-purifying respirator with mercury vapor cartridges, or
  - Face mask with sulfur or iodide impregnated activated carbon, or face mask made of sandwiched activated charcoal-impregnated cloth (Note that face masks that do not seal tightly around the face could allow contaminated air to enter through the edges), or
  - Other specialty mask or respirator designed particularly for mercury, or
  - *If no specialty masks are available*: a face mask with a 0.3 micron HEPA filter to capture amalgam particles and mercury-laden dust (unfortunately, regular masks will NOT protect against mercury vapor)
- Coveralls, apron, and other protective clothing
- Disposable shoe covers

□ Containers:
- Air-tight, sealable plastic bags (small and large sizes, thickness: 2 to 6 mils, or 50 to 150 microns)
- Small, air-tight, rigid plastic container with some water or vapor suppression agent for collecting elemental mercury (see recommendation below)
- Air-tight, puncture-resistant, rigid plastic or steel jar or container with a wide opening for collecting mercury-contaminated broken glass
- Plastic tray
- Regular plastic waste bags (thickness: 2 to 6 mils, or 50 to 150 microns)

□ Tools for removing mercury
- Flashlight (electric torch) to locate shiny mercury beads
- Plastic-coated playing cards or thin pieces of plastic to push mercury beads into a plastic scoop or pan; if these are not available, use index cards, pieces of cardboard, or stiff paper
- Small plastic scoop or plastic dust pan to catch the mercury beads
- Tweezers to remove small broken glass pieces
- Eyedropper or syringe (without the needle) to draw up large mercury beads
- Duct tape or sticky tape to pick up tiny mercury droplets
- Vapor suppression agents:
  - Sulfur powder (available from pharmacies) to absorb mercury by forming mercuric sulfide
  - Zinc or copper flakes (available from hardware stores) to absorb mercury by forming amalgams
  - Commercial absorbent pads or vapor suppressants[7]
  - Brush to remove powder or flakes
- Utility knife blade

□ Materials for decontamination
- Vinegar, hydrogen peroxide, and cotton swabs for final cleaning when using sulfur powder
- Decontaminant solution or commercial decontaminant[8]

[7] An example of a dry vapor suppressant is the Mercon™Tainer (Ross Healthcare) which contains a foam pad saturated with a suspension containing small amounts of sodium thiosulfate, copper sulfate, calcium chloride, and potassium iodide. Small quantities of x-ray fixer (which contains thiosulfate) or a propylene glycol solution of sodium thiosulfate and copper sulfate have also been used as vapor suppression agents.

[8] Decontamination solutions can be made of sodium thiosulfate solution (photographic fixer); or a mixture of sodium thiosulfate and EDTA. Examples of commercially available decontaminant solutions are Spilfyter® Decon Solutions, HgX® Mercury Decontaminant Solution (Acton Technology), and Mercon™ Wipes (Ross Healthcare). Mercon™ uses a mixture of about 0.01% by weight iodine, 0.13% copper sulfate, 0.15% ferric chloride, 1.3% ammonium chloride, and 15% isopropanol and varying amounts of propylene glycol.

- Piece of soap and paper towels

□ "Danger: Mercury Waste" labels to put on waste containers

Whenever a spill kit is used, the most senior staff involved in the cleanup should take responsibility for ensuring that the contents are replenished as soon as possible. All spill kits should have a sheet attached indicating when they were used and verifying that the expended supplies have been replaced. The sheet should be signed and dated by the responsible staff.

*Recommendation*: Healthcare facilities that deal with frequent spills should use a large, air-tight, rigid plastic container or steel flask with some water or vapor suppression agent for accumulating elemental mercury, as well as a large, air-tight, puncture-resistant, rigid plastic or steel container with a wide opening and with water or vapor suppression agent for accumulating mercury-contaminated broken glass. When using water, the water should fully cover the mercury or contaminated glass. Each of these primary containers should be labeled and placed in a secondary container (thick, re-sealable plastic bags) and kept with or near the spill kit. When a spill kit contains accumulation jars or containers, the storage location of the spill kit should be locked, secure, and readily accessible to authorized personnel. Ideally, the storage location should have an exhaust vent to the outside of the facility away from crowded areas.

## 3.0 Cleanup Procedure for Mercury Spills

This detailed mercury spill cleanup procedure was adapted from many sources[9] and is intended as a guide to help develop facility-specific procedures. Each healthcare facility should develop its own procedures according to what is practical and available while maximizing protection for their patients and health workers.

*Recommendation*: After these procedures have been reviewed and modified to meet the needs of a health facility, the procedures should be translated into the local language or dialect as needed. In addition, drawings or graphical illustrations could be used both for training and as a step-by-step reminder during an actual spill.

- **Step 1 – Quickly determine the extent of the spill:** Determine on what surfaces the mercury spilled and how far the mercury beads traveled.

- **Step 2 – Immediately block off foot traffic:** Do not allow anyone to walk across the contaminated site or to go near areas where the mercury traveled. If the extent of a small spill is not immediately obvious, block off traffic for a radius of about 2 meters around the center of the spill.

[9] "Cleaning Up Small Mercury Spills," Environment Canada, updated April 26, 2010 http://www.ec.gc.ca/mercure-mercury/default.asp?lang=En&n=D2B2AD47-1&printerversion=true; "Mercury Releases and Spills," U.S. Environmental Protection Agency, updated December 2, 2009 http://www.epa.gov/hg/spills/; "Mercury Spill Cleanup Instructions," Fact Sheet, Oklahoma Department of Environmental Quality, September 2009; "Mercury Spill Information and Cleanup Guidance," Mercury Awareness Program, Indiana Department of Environmental Management, May 2007; "Managing Small Mercury Spills," Fact Sheet, Health Care Without Harm Europe (Praha, Czech Republic) and Health & Environmental Alliance (Brussels, Belgium), October 2006 http://www.noharm.org/europe/issues/toxins/mercury/resources.php; "Mercury Spill Response & Clean-up Guidance Document," Ohio Spill Planning, Prevention and Emergency Response Association, Columbus, Ohio, 2002; "Cleaning Up Small Mercury Spills," Michigan Department of Environmental Quality, 2002 http://www.p2pays.org/ref/15/14605.htm;

- **Step 3 – Contain the spill:** If necessary, prevent the mercury beads from traveling further by blocking their path with rags or impervious material. Take steps to keep mercury from falling into drains or cracks. Check to see if anyone's skin, shoes or clothing was splashed with mercury. If shoes or parts of clothing were contaminated, they should be removed and left around the spill area before allowing the person to leave. Skin that was in contact with mercury should be washed with an alkaline soap.

- **Step 4 – Evacuate the area:** Ask everyone to leave the room or the general area, giving priority to pregnant women and children. Seek assistance to provide first-aid to anyone requiring immediate medical attention. (See Appendix A.)

- **Step 5 – Minimize the spread of vapors to interior areas:** Close all interior doors that lead to other indoor areas. Turn off central ventilation, heating or air conditioning systems that circulate air from the spill site to other inside areas of the building.

- **Step 6 – Reduce vapor concentrations in the spill area if possible:** After making sure that windows and exterior doors open to outside areas that are free of people, open the windows and exterior doors to dilute the vapor concentrations in the room. Prevent access to the area by putting up signs and, if necessary, seeking help from other staff persons, and then leave the area to prepare for cleanup.

- **Step 7 – Prepare for cleanup:** Remove jewelry, watch, mobile phones, and other metal-containing items. Get the mercury spill kit.

- **Step 8 – Put on personal protective equipment (PPE):** Change to old clothes if possible. Put on the apron or coveralls, disposable shoe covers, rubber or nitrile gloves, goggles, and face mask before re-entering the spill site. Make sure metal items such as eyeglass frames are covered by PPE.

- **Step 9 – Remove visible mercury beads and broken glass:** Place the jar and container on the plastic tray. Starting from the outside of the spill site and moving towards the center, carefully remove visible mercury beads and broken glass. Use tweezers to remove broken glass pieces and place them in the jar or wide-mouthed container over the tray. Using a playing card or piece of plastic, slide the mercury beads onto the plastic dustpan or scoop, and away from any carpet or porous surface. Use a slow, short, sweeping motion to prevent spreading mercury droplets. Carefully place the mercury beads into the plastic container partially filled with water or vapor suppression agent. Do this over the tray to catch any spillage. You can also use an eyedropper or syringe for small beads. Hold the eyedropper or syringe almost parallel to the floor to draw in the beads and keep the eyedropper or syringe horizontal when transferring the beads to the